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To the Editor:

I was dismayed by the President's page in the November 1975 BULLETIN (56, 1152-1153) on the subject of a scientist's responsibility to society. Though it is noble and well intended, it in no way faces the real responsibilities of scientists (I shall include technologists since the distinction has all but disappeared) for the trends society has followed, and still continues to follow. Instead, it pretends that their responsibilities lie only in the area of "presenting the facts" relevant to the questions posed by society, or more bluntly, in answering impartially the questions they are paid to answer.

I can appreciate the desire that scientists should not deliberately "distort the facts" as advocates of a particular cause, but to pretend that our knowledge even in physics, let alone in the environmental sphere, is simple fact ("objective statements") is pure wishful thinking. The proposed creed is a twofold distortion. On the one hand, it implies that there are such things as factual answers. There may be, but they exist only if science is construed in the broadest possible sense to include our whole understanding of the natural world, including man. On the other hand, it suggests a physicist is accountable only within a very narrow field of knowledge. This is a doctrine of the compartmentalization of knowledge, comfortable perhaps for the scientist in his own little field but a disaster for the world because it leaves no one to take account of the broad human predicament.

Scientific models and deductions start from assumptions: assumptions where we are ignorant or deliberate assumptions that are themselves a reflection of our desires (ranging from the aesthetic to what these days are called national "needs"). Scientists as well as society accept these assumptions with too little question. They range from the protection of vested interests to the arrogant assertion of the ability of technology to manipulate the environment to society's "needs," such as exponential economic growth (which is clearly scientifically ridiculous). It is intellectually dishonest for the scientific community to accept these basic assumptions (as "political" questions) and proceed to derive "solutions" based on them that are recognizable as ecological disasters and that, in turn, society implements as the best technical advice.

Even forgetting for the moment the assumptions that come from our vast ignorance about the balance of the natural world, it remains true that most research in the United States is directed to certain goals. Thus, this research is based on assumptions about what society wants or "needs." The research that follows attempts to achieve this goal by applying an appropriate "filter" to the natural world. All scientific models filter in this sense and in doing so necessarily distort our picture of the world. To take an example: if we apply the assumption that atmospheric convection can be parameterized in terms of synoptic scale meteorological fields, we process the data accordingly and derive certain models and conclusions; but these are based on an assumption that in turn comes from the desire to forecast the weather using numerical weather prediction. The closer science is to economic and political questions, the more glaring these assumptions often are. It follows that the scientific analysis based on these assumptions may be worthless.

To reverse the argument, the mess that our technological society is now in is clear evidence that the assumptions on which it is based are unsound. The implication of the November article is that scientists should not get involved, they should just advise. But who will question the assumptions if the technical "experts" do not? Who will predict the consequences of different assumptions if the same "experts" do not? Those advised believe they are doing the best they can because they had the

best technical advice. This collusion can be seen everywhere. Those in power (politicians, industrialists, and scientists) are comfortable and do not want to rock the boat or question vested interests or values: perhaps the problem of future consequences will go away or can be postponed further.

This by now is quite obviously a scientific fraud being perpetrated on mankind, and the implications for society and science will be devastating.

The seriousness of the plight of science in the United States is also evident if we consider this possible hierarchy of allegiances of a researcher (more could clearly be added):

- 1) to the planet Earth;
- 2) to mankind;
- 3) to science;
- 4) to the United States;
- 5) to one's own science (e.g., atmospheric science);
- 6) to one's own specialization;
- 7) to a specific research contract.

Most research appears to owe allegiance to the lowest level, occasionally rising a few levels. This is a dismal prospect for this planet, for mankind, and of course for science itself. I do not think the November article begins to answer these questions.

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Response

I am delighted that Prof. Betts responded so eloquently to the article "Scientists in the public arena" in the November 1975 issue of the BULLETIN, which was mainly a reprint of an editorial by Dr. William W. Havens, Jr., in Physics Today. Issues of this importance need to be debated openly and vigorously if we are to find and play our proper role at the interface of science and public policy. Although Prof. Betts' letter should be more properly answered by Dr. Havens, I will assume that task since I am in essential accord with Havens' position.

First of all, I believe that Betts' response is based in part upon a misinterpretation of Havens' editorial. With respect to the allegation that the Havens' paper suggested that the scientist's role is limited to "presenting the facts" when those "facts" may be based upon gross assumptions or may involve large uncertainties, Havens clearly noted that those uncertainties need to be identified and their significance explained by the scientist. In this respect, I believe Betts, Havens, and I are all in accord.

Indeed, in my own editorial "Selling atmospheric science" (BULLETIN, 56, 688-689), I specifically speak to the need for technology assessments (by scientists and others) including the appraisal of the potential hazards of emerging technologies. But I also cautioned that the full range of assumptions (and uncertainties) needed to be highlighted in such assessments. Surely Betts will agree with my plea in the latter editorial) that we "not clothe our crystal ball gazing in a shroud of false authenticity."

If there is any conflict whatever between Betts and Havens (and me), it seems to be only in the manner in which scientists should be involved in the generation or influence of public policy

decisions. Havens (and I) contend that such decisions must be based upon the full spectrum of forces and possible effects, including those of a political, economic, and social nature. These are certainly outside the realm of expertise of the typical scientist. While the technical expert must question the assumptions and, indeed, the entire process leading to a set of conclusions of the scientific component of a problem, he has no right to pretend that his judgment on the nonscientific aspects is much better than that of a layman. Here, too, I would expect to find Prof. Betts in accord.

I especially like Betts' hierarchy of allegiances of a researcher and the implications that adherence to the lowest levels in that hierarchy have for mankind.

Having found ourselves in such close agreement, I begin to question our abilities to communicate. Perhaps this is a more immediate issue of concern. If scientists cannot speak to one another, how can we expect to communicate with the outside world?

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